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UNMANNED TESTING OF FULLERTON SHERWOOD SIVA VSW UNDERWATER BREATHING APPARATUS (UBA) FOR VERY SHALLOW WATER (VSW) MINE COUNTERMEASURE (MCM) MISSIONS

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OCTOBER 1999

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In response to the continuing challenge of conducting MCM in depths between 10 to 40 fsw, the CNO has authorized the Near Term Mine Warfare Campaign Plan. This plan includes the establishment of the VSW MCM Detachment as a primary supporting unit. Presently, no specific diving apparatus on the ANU list meets the demands set forth by CNO to conduct VSW MCM operations. NEDU has been tasked to test and evaluate the Fullerton Sherwood SIVA VSW UBA to determine if it meets the stringent requirements for operating in this mission area. NAVSEA Diving Safety Certification requirements must be met to achieve the designation of "Authorized for Navy Use" set forth by NAVSEA 00C prior to fielding any UBA in the U.S. Navy. This report deals with the conduct of unmanned diving tests and procedures to verify functional characteristics in accordance with manufacturer's specifications and the VSW MCM UBA Performance Specification.

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INTRODUCTION

In response to the continuing challenge of conducting Mine Counter Measures in depths between 10 to 40 feet of sea water (fsw), the Chief of Naval Operations (CNO) has authorized the Near Term Mine Warfare Campaign Plan. This plan includes the establishment of the Very Shallow Water (VSW) Mine Counter Measure (MCM) Detachment as a primary supporting unit.

Presently, no specific diving apparatus on the Authorized for Navy Use (ANU) list meets the demands set forth by the CNO to conduct VSW MCM operations. The Navy Experimental Diving Unit (NEDU) has been tasked[1] to test and evaluate the Fullerton Sherwood SIVA 55-VSW Underwater Breathing Apparatus (UBA) to determine if it meets the stringent requirements for operating in this mission area.

NAVSEA Diving Safety Certification requirements must be met to achieve the designation of "Authorized for Navy Use" set forth by NAVSEA 00C prior to fielding any UBA in the U.S. Navy. This report deals with the conduct of unmanned diving tests and procedures to verify functional characteristics in accordance with manufacturer's specifications[2] and the VSW MCM UBA Performance Specification[3].

UBA DESCRIPTION

Fullerton, Sherwood Engineering LTD. of Ontario, Canada, originally provided five SIVA 55-VSW UBAs for evaluation. The SIVA 55-VSW is a back-mounted diver life support unit with two over-the-shoulder 7.5 liter capacity breathing bags and cummerbund mounted quick release weight pouches. It is designed to operate with 100% oxygen, 30/70, 40/60, 60/40 and 67.5/32.5% nitrogen/oxygen mixes. The U. S. Navy is primarily interested in the 30% N_2/70% O_2 gas mixture for use to a maximum working depth of 40 fsw (12.3 meters salt water (msw)), the expected working depth range for the VSW MCM Detachment. Figure 1 shows the gas flow path for the UBA.

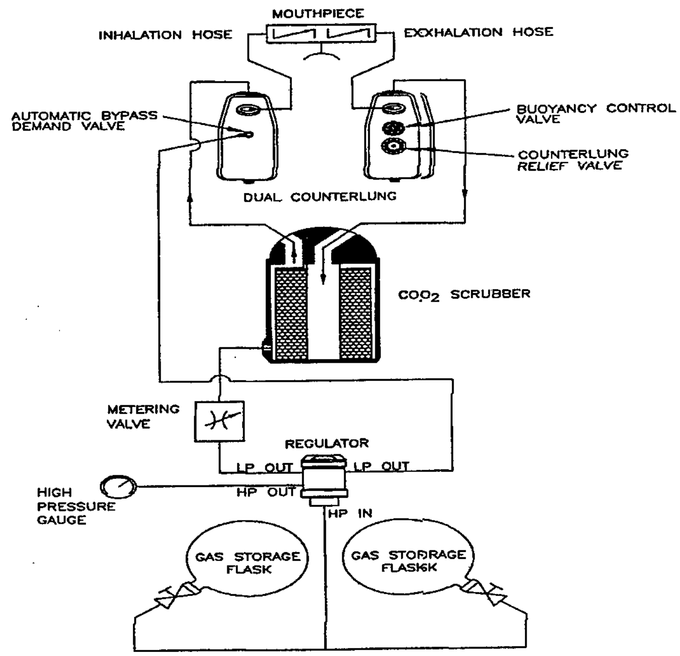


Figure 1. Gas Flow Schematic

The SIVA 55-VSW is a semi-closed circuit rebreather with a collapsible inhalation side counterlung, or breathing bag, and a collapsible exhalation side breathing bag. The diver's exhaled gas is chemically scrubbed of carbon dioxide (CO_2) by the scrubber canister which hold approximately 5.5 lbs. (2.4 kg) of 8-12 mesh absorbent. A portion of the CO_2 rich exhaled gas escapes out the buoyancy control valve ("pepper valve") on the exhalation bag. Under environmental conditions of standard temperature and pressure, dry, (STPD), a constant 4.5 liters per minute (lpm) of the 30% N_2/70% O_2 gas mixture compensates for the diver's metabolic O_2 usage. The flasks incorporate DIN type fittings that allow the flask assembly to be rated at 3,500 psig (241.3 bar or 24.1 MPa). Flasks have a nominal floodable volume of 2.8 liters.

The UBA has an incorporated buoyancy control device (BCD)/life vest worn between the diver's back and the UBA's backpack. The BCD utilizes a single independent gas supply source. Figure 2 is a frontal view of the UBA, and Figure 3 is a back view with the cover removed. The BCD is not shown.

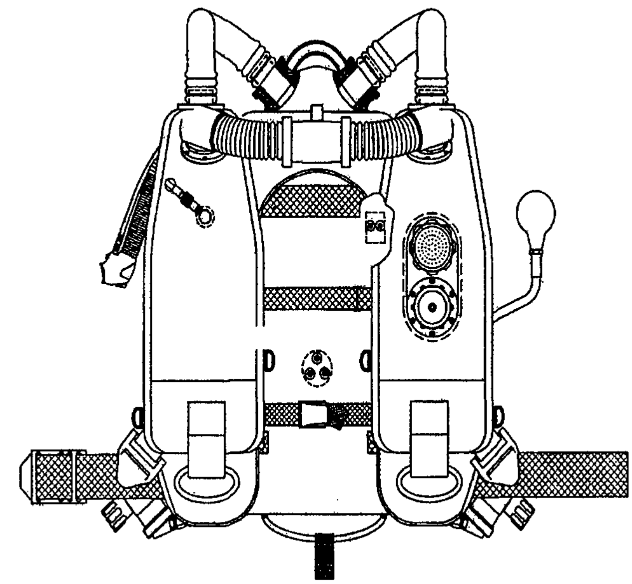
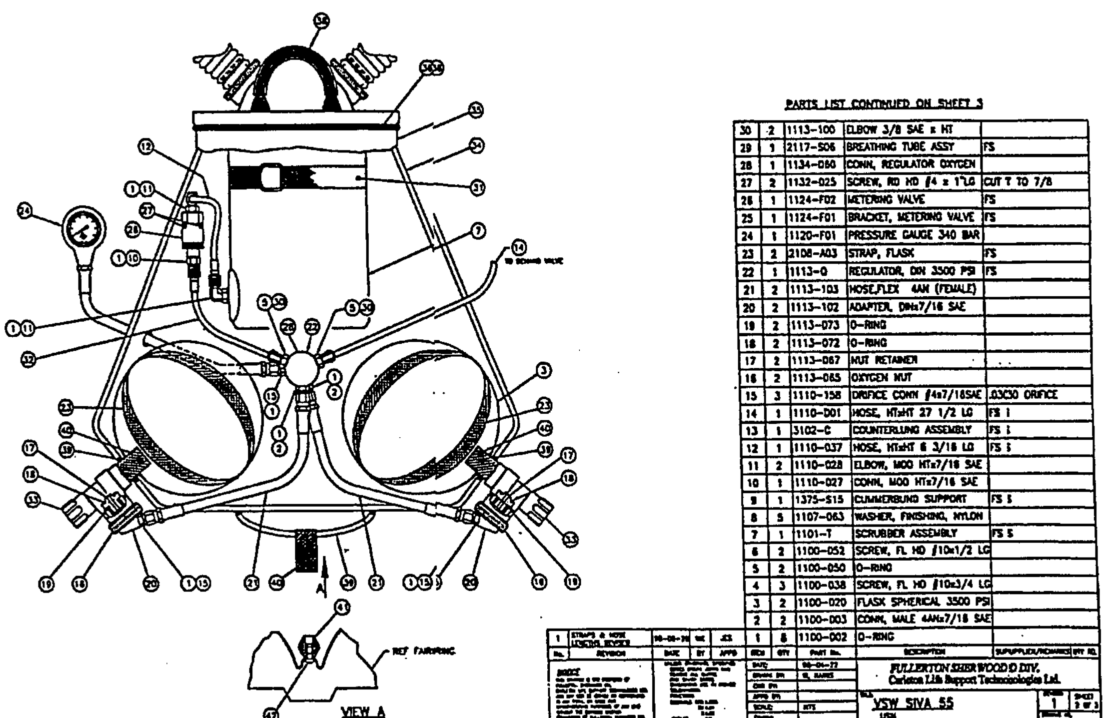


Figure 2. Counterlung Orientation



PARTS LIST CONTINUED ON SHEET 3

ITEM	QTY	PART No.	DESCRIPTION	REMARKS
30	2	1113-100	ELBOW 3/8 SAE x HT	
29	1	2117-506	BREATHING TUBE ASSY	FS
28	1	1134-060	CONN, REGULATOR OXYGEN	
27	2	1132-025	SCREW, RD HD #4 x 1"LG	CUT T TO 7/8
26	1	1124-F02	METERING VALVE	FS
25	1	1124-F01	BRACKET, METERING VALVE	FS
24	1	1120-F01	PRESSURE GAUGE 340 BAR	
23	2	2108-A03	STRAP, FLASK	FS
22	1	1113-0	REGULATOR, DIN 3500 PSI	FS
21	2	1113-103	HOSE,FLEX 4AN (FEMALE)	
20	2	1113-102	ADAPTER, DINx7/16 SAE	
19	2	1113-073	O-RING	
18	2	1113-072	O-RING	
17	2	1113-067	NUT RETAINER	
16	2	1113-065	OXYGEN NUT	
15	3	1110-158	ORIFICE CONN #4x7/16SAE	.0030 ORIFICE
14	1	1110-D01	HOSE, HTxHT 27 1/2 LG	FS 1
13	1	3102-C	COUNTERLUNG ASSEMBLY	FS 1
12	1	1110-037	HOSE, HTxHT 6 3/16 LG	FS 1
11	2	1110-028	ELBOW, MOD HTx7/16 SAE	
10	1	1110-027	CONN, MOD HTx7/16 SAE	
9	1	1375-515	CUMMERBUND SUPPORT	FS 5
8	5	1107-063	WASHER, FINISHING, NYLON	
7	1	1101-T	SCRUBBER ASSEMBLY	FS 5
6	2	1100-052	SCREW, FL HD #10x1/2 LG	
5	2	1100-050	O-RING	
4	3	1100-038	SCREW, FL HD #10x3/4 LG	
3	2	1100-020	FLASK SPHERICAL 3500 PSI	
2	2	1100-003	CONN, MALE 4ANx7/16 SAE	
1	8	1100-002	O-RING	

Figure 3. Internal Components

Table (1) compares the physical characteristics of the MK 16, the SIVA 55 and the SIVA 55-VSW UBA:

Table 1. UBA Dimension Comparison

UBA	Weight in Air (lbs.)	Length (inches)	Width (inches)	Depth (inches)
MK 16	64	23.6	14.9	10.5
SIVA 55	64	24	14.6	7.5
SIVA 55 VSW	51	20	19	10

METHODS

Unmanned UBA test procedures were conducted[4] in eight phases:

GAS SUPPLY DURATION

Gas duration tests were completed at 40 fsw (12.3 msw) with a respiratory minute volume (RMV) of 40 lpm. Gas flasks were charged at the maximum bottle pressure of 3,500 $\pm$ 10 psig. The metering valve was set at 4.5 lpm for the gas mixture of 30% nitrogen/70% oxygen, and the regulator output pressure was set at 185 $\pm$ 15 psig as required by the manufacturer's operation manual[2]. The gas duration was determined when the gas supply pressure no longer provided 4.5 lpm to the breathing loop.

BREATHING RESISTIVE EFFORT

Resistive breathing effort measurements were conducted at 0, 33, 66, and 99 fsw (0.0, 10.1, 20.2, and 30.3 msw, respectively) with the five standard[5] breathing RMV rates of 22.5, 40.0, 62.5, 75.0 and 90.0 lpm. Because temperature has no effect on breathing resistive effort, all testing was conducted at ambient temperature using Battelle Breathing Simulator with a PC-based data acquisition system. The original intent was to test the SIVA UBA in both the standard mouth bit and full-face mask (FFM) configurations. The Fullerton Sherwood FFM contains a highly flexible mouth bit that the diver keeps in his mouth throughout the dive with minimal or no discomfort. Because the FFM did not alter or modify the breathing loop, all unmanned testing was conducted with the standard mouthpiece.

NOTE: All unmanned testing was completed with the buoyancy control valve ("pepper valve") set at one-half turn open (180 degrees) position. This was determined to be the approximate mid-range setting. UBA pre-dive set-up and post-dive breakdown was completed as per manufacturer's specifications [2] unless otherwise noted.

CO_2 ABSORBENT CANISTER DURATION

Five canister duration runs were conducted at each of the following water temperatures ± 2°: 32°, 50°, 70° and 90° F (0°, 10°, 21.1° and 32.2°C). CO_2 injection rate was set at 1.35 lpm, STPD, with a ventilation rate of 40 lpm RMV. A CO_2 injection rate of 1.35 lpm is assumed equivalent to the CO_2 production associated with an oxygen consumption rate of 1.5 lpm, representing an average diver at a moderate work rate[6].

During preliminary testing, we noted that to accurately replicate CO_2 flow through the UBA, our simulated oxygen consumption procedure needed to be run simultaneously with canister duration testing. CO_2 levels were monitored intermittently at depth until CO_2 reached a concentration of 0.5% and 1.0% surface equivalent volume (SEV). A Rosemount 880A CO_2 analyzer monitored CO_2 concentration levels.

The UBA's canister basket was pre-packed with non-indicating Sofnolime 812 (10-14 U.S. mesh) in accordance with the manufacturer's suggested procedures. The average weight of the packed absorbent basket was 6.8 ± 0.2 lbs. (3.0 ± 0.1 kg), considerably higher than the 5.5 lbs (2.4 kg) recommended in the manufacturer's Operations and Maintenance Manual[2]. However, after consulting with a technical representative from the manufacturer and the program sponsor, this amount was agreed upon in order to achieve a tightly packed canister and prevent channeling of the breathing gas as it passed through the absorbent bed.

OXYGEN CONSUMPTION SIMULATION

Oxygen consumption measurements were taken at 33, and 66, fsw (10.1and 20.2 msw, respectively) with the five standard[5] breathing RMV rates of 22.5, 40.0, 62.5, 75.0 and 90.0 lpm. Because temperature has no effect on O_2 consumption, all testing was conducted at ambient temperature with a Battelle Breathing Simulator with a PC-based data acquisition system. The oxygen consumption values used have been shown through physiological research to be the equivalent oxygen consumption rates of an average diver at rest (22.0 RMV) and at severe (90.0 RMV) work rates[6]. Removing a fixed rate of gas from the UBA and returning a lesser amount of pure nitrogen will perform the oxygen consumption simulation. The amount of gas that was withdrawn and replaced will be determined by a computer based data acquisition system (DAS) consisting of a 200MHz Pentium Pro Gateway computer system, National Instruments data acquisition input/output cards and Labview data collection software. Gas was withdrawn from the UBA at a point adjacent to the inhalation side of the diver's mouthpiece. Prior to proceeding from one RMV to the next at each depth, O_2 levels within the breathing loop were allowed to stabilize. Oxygen levels were monitored with a Rosemount 755 O_2 analyzer. Throughout the dive, a variable amount of gas, controlled by a computer algorithm and computer controlled mass flow meters, was removed from the breathing loop and a lesser amount of pure nitrogen was injected,

again using computer controlled mass flow meters. Since semi-closed UBA have O_2 levels that vary with depth and work rate, the amount of gas removed from the UBA to simulate a given oxygen consumption must vary in inverse proportion to the UBA's O_2 level. A Beckman 755 O_2 analyzer measured O_2 percentage.

INTEGRAL BUOYANCY CONTROL DEVICE

The integral buoyancy control device (BCD) or life vest, was tested in two phases, unmanned and manned under NEDU Standard Test Plan 98-47[7].

STORAGE TESTING

Cold storage testing was used to determine if the UBA would perform properly after being subjected to Arctic storage temperatures. The SIVA 55-VSW UBA was placed in cold storage at a temperature of -20°F (-28.6°C) for four days in a non-standby mode, then removed from storage and allowed to warm to room temperature. When the UBA reached room temperature, pre-dive set-up procedures were conducted to ensure the UBA could operate properly following cold storage.

PRE- AND POST-DIVE PROCEDURES

The manufacturer's pre- and post-dive procedures[2] were examined and compared to procedures of other approved U.S. Navy UBA. Particular consideration was given to thoroughness of the documentation, and to attention given to the components and procedures involved in safe operation of the UBA.

RELIABILITY AND MAINTAINABILITY

Each individual UBA had its own specific dive log and maintenance record. The type, duration and accumulated dive times were compiled. Each planned and corrective maintenance action performed was described in detail, providing evidence of any deficiencies in construction or operation.

RESULTS

GAS SUPPLY DURATION

The specified minimum UBA compressed gas flask duration[3] was 180 minutes at 40 fsw (12.3 msw) with a goal of 240 minutes. Each test began with a fully charged gas flask, 3,500 ± 10 psig and regulator output pressure set at 185 ± 15 psig. Run #1 lasted 289 minutes, Run # 2 lasted 259 minutes, with the average duration being 274 minutes.

BREATHING RESISTIVE EFFORT

Figure 4 shows how resistive effort was better than the stated performance requirement[3] of 3.0 kPa at a respiratory rate of 62.5 L/min RMV at 60 fsw (18.4 msw). Furthermore, the unit came close to meeting the goal of 1.2 kPa at 40 fsw (12.3 msw) which was obtained at 33 fsw instead of 40 fsw.

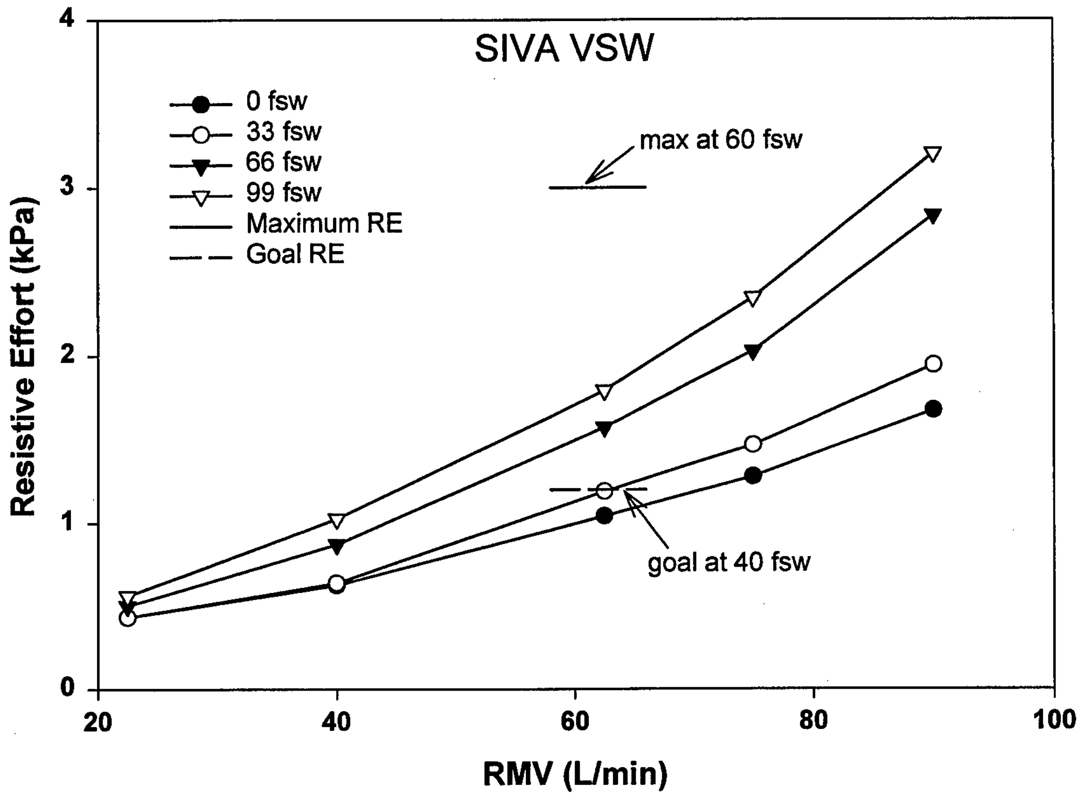


Figure 4. Breathing Resistive Effort Results

CO_2 SCRUBBER PERFORMANCE

The VSW MCM UBA is required to operate for a minimum of 180 minutes at a depth of 40 fsw (12.3 msw) with a goal of 240 minutes[3]. Throughout the dive duration, the maximum average amount of CO_2 present in the breathing loop at the point of diver inhalation should not exceed 0.5% SEV. Table 2 shows the time to reach 0.5% SEV of CO_2 for each of the test temperatures.

Table 2. Time in minutes to reach 0.5% SEV CO_2

Temperature	Run #1	Run #2	Run #3	Run #4	Run #5
32°	229	241	230	205	188
50°	242	219	240	200	227
70°	289	277	266	295	254
90°	283	261	272	270	284

Figure 5 shows the raw duration data and resulting canister limits. Canister limits in Table 3 are derived from the lower 95% prediction limits (lower dashed line), and exceeded 180 minutes at water temperatures of 39° F and above. The procedure and rationale for obtaining those limits are described in NEDU Report 2-99[8].

Table 3. SIVA 55 VSW canister limits

°F	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
min	170	175	180	190	195	200	205	210	215	220	225	230	235

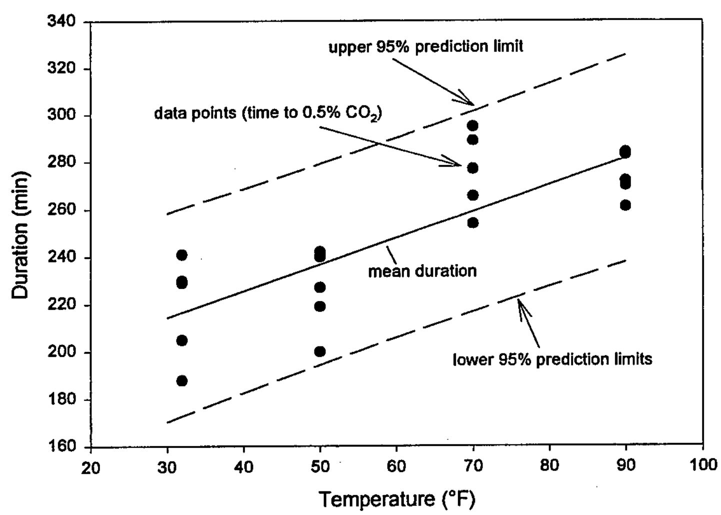


Figure 5. Canister Limit Results

O_2 CONTROL

At an RMV rate of 22.5, oxygen levels in the UBA rose to 1.88 ATA PPO_2 at 66 fsw (20.2 msw) and stayed at this level until the RMV rate was increased. Table 4 shows the PPO_2 obtained in the breathing bags after rig stabilization at 33 fsw (10.1 msw) and 66 fsw (20.2 msw). At 90 RMV the UBA was unable to reach and maintain a bag level PPO_2 steady state.

At the lower RMV rates of 22.5 and 40.0 and deeper depth of 66 fsw (20.2 msw), the UBA controlled the diver bag level PPO_2 at a level that would be expected for a diver at rest but are above the bag level PPO_2 in the UBA specification[2]. At the RMV rates that would normally be seen by a diver working at a moderately heavy /heavy/severe rate[5] the UBA controlled the bag level PPO_2 within the limits of the UBA specifications[4]. At the extreme work rate of 90 RMV, the UBA was unable to control the bag level PPO_2 and never reach stabilization. Within 3-5 minutes the PPO_2 levels within the UBA fell below the minimum[4] of 0.30 ATA PPO_2. This was due to fact that O_2 consumption was at a greater rate than the UBA could provide O_2 at the pre-set flow rate of 4.5 L/min STPD.

Table 4. Bag Level PPO_2

RMV	***33 FSW***	***66 FSW***
22.5	1.26 ATA PPO_2	1.88 ATA PPO_2
40.0	1.15 ATA PPO_2	1.74 ATA PPO_2
62.5	0.88 ATA PPO_2	1.32 ATA PPO_2
75.0	0.70 ATA PPO_2	0.98 ATA PPO_2
90.0	NO STABILIZATION	NO STABILIZATION

INTEGRAL BUOYANCY CONTROL DEVICE (BCD)

The Integral BCD/life vest results will be detailed in a separate NEDU Technical Memorandum 99-04[9].

STORAGE TESTING

The UBA showed no external ill effects from the cold storage testing and pre-dive procedures were performed without incident with one exception. During the final leak check of the pre-dive set-up procedures, gas bubbles were detected on the canister assembly along the threaded and epoxied seam where the upper brass sealing ring mates with the plastic lower absorbent housing cup. Apparently, a gas bubble in the epoxy material expanded as the UBA warmed causing the seal to leak. This problem was addressed to the manufacturer and an interim solution was to replace the epoxy seal with an O-ring seal. Testing of this seal will be performed by an independent laboratory and reported on separately.

PRE- AND POST-DIVE PROCEDURES

The manufacturer's pre- and post-dive procedures[2] were found to be inadequate because they did not provide the level of detail and chronological step-by-step procedures normally associated with U. S. Navy UBA checklists.

RELIABILITY AND MAINTAINABILITY

An assessment of reliability and maintainability will be documented after Requirements Compliance Testing (RCT)[10] fleet user evaluation is conducted at the VSW MCM Detachment.

CONCLUSIONS

The Fullerton Sherwood SIVA 55-VSW UBA meets the manufacturer's advertised performance levels and the VSW MCM UBA Performance Specification[3] in the areas of gas supply duration and breathing resistive effort and cold storage. However the UBA fell short of the specifications in the areas of CO2 scrubber performance and O_2 control.

The specifications[3] for canister duration called for it to last for 130% of the gas supply duration. After some initial testing[4] this was considered to be an unrealistic goal for this or any other UBA. Members of the Integrated Products Team (IPT), which consists of NEDU, PMS-EOD, and NAVSEA, met to discuss this requirement and determined that this was an unrealistic goal. The specification[3] for the canister duration was changed to read it should simply last longer than the gas supply duration, which it still does not. Based on the results of the canister duration study[11], a canister duration of 180 minutes can be expected at temperatures of 39°F (3.9°C) or above.

Although bag level PPO_2 was exceeded at 66 fsw for the lower RMV rates (22.5, 40.0) it must be kept in mind that this UBA has a maximum operating depth[3] of 40 fsw (12.3 msw). At normal work rates at the maximum operating depth, the diver should not experience PPO_2 levels above 1.3 ATA PPO_2. In addition, our tests show that the UBA was unable to maintain a stable bag level PPO_2 at the severe work rate of 90 RMV and within three to five minutes bag level PPO_2 fell below the UBA specification[3] of 0.30 ATA PPO_2. We feel that this is an exercise rate that approaches a person's maximum VO_2, and is unlikely to be experienced in a VSW MCM scenario.

RECOMMENDATIONS

1. The results of this study indicate that the SIVA 55-VSW UBA can be safely transitioned to manned studies as long as recommendations listed below are followed. Initial manned studies should be conducted in the NEDU test pool to characterize the actual breathing bag PO_2 and PCO_2 levels under various workloads before manned dives to the maximum working depth of 40 fsw (12.3 msw) are conducted.

2. A detailed checklist must be developed to ensure proper UBA operation for pre-and post-dive procedures. Recommended pre-, post-dive and diving supervisor checklists are provided in Appendices A, B, and C.

3. For dives conducted in water temperatures below 29°F (-1.6°C), canister duration should be limited to 160 minutes. For temperatures 30°F (-1.1°C) and above, refer to Table 3 of this report.

4. To minimize the potential for CO_2 channeling, recommend that the absorbent canister be filled with approximately 6.8 ± 0.2 lbs. (3.0 ± 0.1 kg) of 812 mesh absorbent material for all manned dives.

5. We recommend that an O-ring seal be used instead of the epoxy seal currently being used to seal the upper brass sealing ring to the plastic lower absorbent housing cup.

6. For manned diving, we recommend that a diver begin work immediately upon reaching the bottom in order to prevent a high PPO_2 in the breathing loop. We also recommend that the diver does not attempt a severe work rate of 90 RMV for more than three minutes. This will prevent a decrease in bag level PPO_2 to a limit below the UBA specification of 0.30 ATA PPO_2.

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APPENDIX - A

PREDIVE CHECKLIST FOR SIVA 55-VSW UBA

DIVER:____________________RATE/RANK:__________DATE:__________

UBA SERIAL NO:____________

__________1) Inspect UBA; look for missing, broken or deteriorated components, ensure that all brass hose end fittings are lubricated and hand tight.

__________2) Fill canister basket with Sofnolime, pack tightly (approximately 6.8 ± 0.2 lbs.), and verify that a foam disk is located on the top and bottom of the basket. Lubricate basket threads and secure.

__________3) Lubricate canister lid O-ring and seat into canister housing, aligning the two non-mag stickers (sharp slope towards diver/gradual slope away from diver). Turn locking ring until it locates into the three recesses on the canister, rotate locking ring to off set recesses and then tighten down locking screw.

__________4) Secure the canister in the back pack (brass fitting to the left), and fasten the velcro retaining strap to secure the canister in place.

__________5) Using the SIVA 55-VSW flask gauge, record flask pressure readings:

Flask #1_________ **Flask #2**_________

__________6) Position the flasks into the back pack, and secure with the rubber straps.

__________7) Inspect the flask connection fittings to ensure they are free of all dirt, debris, etc. Hand tighten the fittings to the flasks, and secure them in place with the hold down straps.

__________8) Check/adjust UBA flow rate **(4.5 LPM FOR THE GAS MIX OF 30% N_2/70% O_2)**. Cap demand valve hose. Connect the braided hose from the meeting valve to the flow meter. Turn on the flask valves and check the flow rate from the middle of the black ball on the flow meter. Adjust flow (if necessary) following procedure in O&M manual. Secure the flask valves, and record the flow reading: ______**LPM**

__________9) Connect braided hose to the canister fitting.

__________10) Secure the cover fairing to UBA.

__________11) Flip over the rig onto the cover fairing. Slide the inhalation bag into left side of counterlung assembly and exhalation bag on the right side. Zip closed and secure velcro.

__________12) Tighten drain plugs on the bottom of both breathing bags. Verify weights are in the counterlungs.

__________13) Lubricate breathing loop O-rings, assemble to canister and breathing bags.
**** VERIFY CORRECT INSTALLATION OF ONE WAY VALVES.**

__________14) Connect braided hose from regulator to demand valve on inhalation bag. Ensure to run hose under fabric on the shoulder of the counterlung assembly.

__________15) Ensure the emergency floatation bottle is fully charged. Record pressure and secure into place. _____**PSIG**

__________16) Inspect adjustable harness straps for excessive wear, don UBA and adjust harness. Add weights to quick release weight pouches as appropriate for individual diver and mission profile.

__________17) Completely deplete the breathing bags - by repeatedly inhaling through the mouth and exhaling through the nose.
****NOTIFY DIVING SUPERVISOR FOR DIVE SUP CHECKS!**

__________18) Leak check: Close mouthpiece, (surface position) secure the buoyancy control valve, remove the cover fairing, open flask valves and immerse entire rig into water, and check for leaks.

__________19) Secure flask valves, reinstall cover fairing, and leave air in UBA.

__________20) Stow rig (if applicable) for not more than seven days. Check flow within 24 hours prior to diving UBA, record flow. _____**LPM**

REMARKS:____

____

OPERATOR SIGNATURE ____________________ DIVING SUPERVISOR____________________

APPENDIX - B

POSTDIVE CHECKLIST SIVA 55-VSW UBA

DIVER:____________________RATE/RANK__________DATE:__________

UBA SERIAL NO:____________

__________1) Soak/rinse UBA in fresh water.

__________2) Remove the breathing hose assembly, unscrew mouthpiece, and rinse thoroughly in sanitizing solution, and rinse in fresh water. Hang to dry.

__________3) Disconnect demand valve hose, cap, and remove inhalation bag and then remove exhalation bag. Thoroughly rinse bags, loosen drain plugs and hang to dry.

__________4) Remove cover fairing, disconnect metering valve hose from canister, cap hose, and remove the canister. Dispose of Sofnolime through the local hazardous waste facility and rise basket and canister in fresh water. Hang to dry.

__________5) Remove flasks and cap both flask valve and flask connecting hose. Stow for charging.

__________6) Attach cover fairing and hang UBA by handle and allow to dry.

*****NOTE: Depending on the conditions of the dive, the soft weight bags may need to be rinsed thoroughly, since normal soaking procedures may not be adequate to remove sand and mud.*****

APPENDIX - C

DIVING SUPERVISOR CHECKLIST FOR SIVA 55-VSWUBA

SUPERVISOR:_______________RATE/RANK:__________ DATE:__________

UBA SERIAL NO:___________________

__________1) Perform negative pressure leak test on SIVA 55 VSW:

a. Have diver breathe down rig; close mouthpiece and let rig sit for **one minute**.
b. Open mouthpiece and listen for vacuum loss, then close mouthpiece to surface position.

__________2) Check for tightness/operation of all rig fittings/components:

a. Exhaust valve and buoyancy control valve.
b. Demand valve. Check hose fitting to demand valve, ensuring hose is under fabric.
c. Breathing loop connections.
d. Gas routing connections.
e. Check drain plugs for tightness.

__________3) Verify that the diver has adjusted and weighted the UBA for his/her particular body size and mission profile.

__________4) Verify the emergency floatation bottle has been charged and pressure is noted in pre-dive checklist.

__________5) Verify that gas flasks are charged to support mission profile, pressures noted on pre-dive checklist.

__________6) Verify that diver has checked flow rate: **(4.5 LPM for 70%N_2/70%O_2)** flow noted on pre-dive checklist.

__________7) Verify completion of pre-dive checklist.

DIVE SUPERVISOR:______________________________